

AMENDMENTS TO THE CLAIMS

A detailed listing of all claims that are, or were, in the present application, irrespective of whether the claim(s) remain(s) under examination in the application is presented below. The claims are presented in ascending order and each includes one status identifier. Those claims not cancelled or withdrawn but amended by the current amendment utilize the following notations for amendment: 1. deleted matter is shown by strikethrough for six or more characters and double brackets for five or fewer characters; and 2. added matter is shown by underlining.

1. (Currently Amended) A method of evaluating the position of a time-varying disturbance on a transmission link, the method comprising:

copying, at least in part, an output signal from an optical pulse source, such that there is a pair of signal copies by channeling light from the optical source onto first and second paths such that the power of the optical source traveling along each path is shared in a predetermined manner between the signal copies and one signal copy travels along the first path in an outbound direction with the other signal copy traveling along the second path in the outbound direction;

delaying one of the pulse copies relative to the other pulse copy in the outbound direction;

combining light traveling in the outbound direction;

transmitting the combined light of the differentially delayed pair of signal copies onto the transmission link in the outbound direction;

receiving in a return direction from the transmission link return signals comprising backscattered components comprising at least partially returned copies of said signal copies previously transmitted on said transmission link, wherein at least one of said backscattered components has suffered a phase change caused by said time-varying disturbance;

combining the received returned signal copies of a transmitted pair so as to produce a combination signal; and

using a temporal characteristic in the combination signal of received returned signal copies of a transmitted pair which has traveled along the transmission link to beyond the location of the time-varying disturbance to evaluate the position of the time-varying disturbance on the transmission link,

wherein the position of the disturbance is determined from the time of return of said phase-modulated backscattered components of said returned signal copies, the phase-modulated backscattered components including backscattered components of a given pair of pulse copies that are phase-modulated by the disturbance on return.

2. (Original) A method as claimed in claim 1, wherein the temporal characteristic includes the time at which a disturbance feature occurs in the combination signal.

3. (Previously Presented) A method as claimed in claim 1, wherein said returned backscattered components comprise signal copies returned by a process of distributed backscattering as the signal copies travel along the transmission link.

4. (Previously Presented) A method as claimed in claim 3, wherein the optical pulse source ~~is~~ signal copies are combined to give a combination signal that is distributed over time as the combined signal copy pulses travel along the transmission link.

5. (Previously Presented) A method as claimed claim 1, wherein:

the combination signal is sampled at a first set of spaced apart temporal positions and at a second set of temporal position, and

the first and second sampled sets are compared in a comparison step.

6. (Original) A method as claimed in claim 5, wherein the temporal positions of the first and second sets are interleaved.
7. (Previously Presented) A method as claimed in claim 5, wherein the comparison step involves generating a set of data which is at least in part dependent on the difference between the first and second sets.
8. (Canceled).
9. (Canceled).
10. (Previously Presented) A method as claimed in claim 1, wherein the differential delay is caused at an unbalanced interferometer coupled to an optical source, the interferometer having a first path and a second path, the transit time of the first path being longer than that of the second path, signal copies of a pair being caused to travel along a different respective path to one another.
11. (Original) A method as claimed in claim 10, wherein the interferometer has a first coupling stage which is coupled to the source, the coupling stage being arranged to channel one portion of the incoming radiation intensity from the source along one path, and another portion of the incoming radiation intensity along the other path, so as to form the first and second signal copies.

12. (Original) A method as claimed in claim 11, wherein the interferometer has a second coupling stage for combining radiation from the first and second paths, and for coupling the combined radiation to the common communications link.

13. (Previously Presented) A method as claimed in claim 12, wherein the signals returned from the second location are each channeled along the first and second paths by a second coupling stage, and wherein the so channeled signals are subsequently combined at the first coupling stage.

14. (Previously Presented) A method as claimed in claim 1, wherein the signal copies of a pair are delayed relative to one another at a first location, and wherein a disturbance is detectable at a second location remote from the first location.

15. (Previously Presented) A method as claimed in claim 1, wherein each of the signal copies of a pair is disturbed by a detected disturbance.

16. (Canceled).

17. (Previously Presented) A method as claimed in claim 1, wherein the output signals have an average phase-coherence time associated therewith of less than 1 pico seconds.

18. (Original) A method as claimed in claim 17, wherein the signal copies of a pair have a differential delay time associated therewith, the delay time being greater than the average phase-coherence time by a factor of at least 1000.
19. (Previously Presented) A method as claimed in claim 1 wherein the transmission link includes an optical fibre extending along a guide track, the guide track being arranged to guide the movement of a vehicle, the optical fibre being arranged such that movement of the vehicle causes a disturbance along the optical fibre.
20. (Previously Presented) A method as claimed in claim 19, wherein the path of the optical channel crosses the track at intervals.
21. (Previously Presented) A method as claimed in claim 19, wherein the guide track has the form of one or more rails for guiding the movement of a train.
22. (Canceled).
23. (Previously Presented) A apparatus as claimed in claim 35, wherein the monitoring means includes a display device for displaying the combination signals as a function of time.
24. (Canceled).

25. (Previously Presented) A apparatus as claimed in claim 34, wherein delay means is provided by an interferometer stage, the interferometer stage having first and second transmission legs and coupling means for coupling to or from the first and second legs, and wherein the means for copying output signals and the means for combining the received signal copies are formed in common by the coupling means.

26. (Currently Amended) A monitoring station for monitoring a transmission link, the monitoring station comprising:

- a source for generating optical pulse signals;

- an interferometer stage for copying at least in part the optical pulse signals from the source such that for each optical pulse signal there is a pair of pulse signal copies, the interferometer stage having a delay stage to differentially delay one copy of each pulse signal relative to the other copy;

- an output for launching the differentially delayed pulse signal copies onto the transmission link; and

- a processor circuit;

- wherein the interferometer stage is arranged to receive pulse signal copies returned by a process of distributed backscattering from the link and to combine the pulse signal copies so as to produce an interference signal, wherein at least one of said backscattered signal copies has suffered a phase change,

- wherein the processor circuit is arranged to store the interference signal in association with an indication of a temporal characteristic of the return signal, and

wherein when said phase change is caused by a time-varying disturbance, said interference signal stored in association with an indication of a temporal characteristic of the return signal copies of a transmitted pair which has traveled along the transmission link to beyond the location of the time-varying disturbance enables the position of the disturbance to be determined from the time of return of phase-modulated backscattered components of said returned pulse signal copies, the phase-modulated backscattered components including backscattered components of a given pair of pulse copies that are phase-modulated by the disturbance on return.

27. (Original) A monitoring station as claimed in claim 26, wherein the interference signal is a time-distributed signal which varies with time, and wherein a temporal characteristic is the time variation of the return signal.

28. (Previously Presented) A monitoring station as claimed in claim 26, wherein the interference signal is a time-distributed signal, and the processor circuit is arranged to sample the interference signal at intervals, and to store the samples in association with a respective return time for each sample.

29. (Canceled).

30. (Currently Amended) A sensing system for sensing the position of a moving vehicle, the sensing system comprising:

a guide track for guiding the movement of the vehicle;
an optical transmission link extending along the guide track; and
monitoring apparatus coupled to the optical transmission link,
wherein the optical transmission link is mechanically coupled to the guide track such that movement of the vehicle causes a moving disturbance to be sensed by sensing optical signal pulse signals propagating along the optical transmission link,

wherein the monitoring apparatus comprises:

a source for generating the sensing optical pulse signals;

an interferometer stage for copying at least in part the optical pulse signals from the source such that for each optical pulse signal there is a pair of pulse signal copies, the interferometer stage having a delay stage to differentially delay one copy of each pulse signal relative to the other copy;

an output for launching the differentially delayed pulse signal copies onto the transmission link; and

a processor circuit;

wherein the interferometer stage is arranged to receive pulse signal copies returned by a process of distributed backscattering from the link and to combine the pulse signal copies so as to produce an interference signal, wherein at least one of said backscattered signal copies has suffered a phase change, and

wherein the processor circuit is arranged to store the interference signal in association with an indication of a temporal characteristic of the return signal,

wherein, when said phase change is caused by a time-varying disturbance, said interference signal stored in association with an indication of a temporal characteristic of the return signal copies of a transmitted pair which has traveled along the transmission link to beyond the location of the time-varying disturbance enables the position of the disturbance to be determined from the time of return of phase-modulated backscattered components of said returned pulse signal copies, the phase-modulated backscattered components including backscattered components of a given pair of pulse copies that are phase-modulated by the disturbance on return,

the monitoring apparatus being configured to:

- (i) detect said sensing optical pulse signal from the optical transmission link, wherein said sensing light signal is indicative of the moving disturbance,
- (ii) evaluate at least one temporal characteristic of the sensing optical signal, and
- (iii) in dependence on the evaluated temporal characteristic, determine an indication of the position of the moving disturbance along the transmission link so that the position of the vehicle along the track can be sensed.

31. (Currently Amended) A method of sensing the position of a vehicle moving along a guide track, wherein there is provided an optical transmission link extending along the guide track, and monitoring apparatus coupled to the optical transmission link, the optical transmission link being mechanically coupled to guide track such that movement of the vehicle causes a moving disturbance to be sensed by combined differentially delayed copies of a sensing optical pulse

signal propagating in an outward direction along the optical transmission link, the method comprising:

(i) detecting backscattered signal components of said outwardly propagating combined differentially delayed copies of said optical signal from the optical transmission link, said backscattered signal components being indicative of a moving disturbance;

(ii) evaluating at least one temporal characteristic of the detected backscattered signal components;

(iii) in dependence on the evaluated temporal characteristic, determining an indication of the position of the moving disturbance along the optical transmission link; and

(iv) inferring the position of the vehicle from the position of the disturbance along the optical transmission link,

wherein the position of the disturbance is determined from the time of return of phase-modulated backscattered components which have traveled along the optical transmission link to beyond the location of the time-varying disturbance, the phase-modulated backscattered components including back-scattered components of a given pair of pulse copies that are phase-modulated by the disturbance on return.

32. (Canceled).

33. (Canceled).

34. (Currently Amended) An apparatus for evaluating the position of a time-varying disturbance on a transmission link, the apparatus including:

means for copying, at least in part, an output signal from an optical pulse source, such that there is a pair of pulse signal copies by channeling light from the optical source onto first and second paths such that the power of said optical source traveling along each path is shared in a predetermined manner between said signal copies and one signal copy travels along said first path in an outbound direction with the other signal copy traveling along the second path in said outbound direction;

delay means for delaying one of the pulse copies relative to the other pulse copy in said outbound direction;

means for combining light traveling in the outbound direction;

means for transmitting the combined light of the differentially delayed pair of signal copies onto the transmission link in an outbound direction;

wherein said means for combining provides means for receiving in a return direction from the transmission link return signals comprising backscattered components comprising at least partially returned copies of said signal copies of a transmitted pair which has traveled along the transmission link to beyond the location of the time-varying disturbance previously transmitted on said transmission link, wherein at least one of said backscattered components has suffered a phase change caused by said time-varying disturbance;

wherein said means for copying provides means for combining the received returned signal copies of a transmitted pair so as to produce a combination signal; and

means for evaluating using a temporal characteristic in the combination signal the position of the time-varying disturbance on the transmission link, whereby the position of the disturbance is determined from the time of return of said phase-modulated backscattered components of said returned signal copies, the phase-modulated backscattered components including backscattered components of a given pair of pulse copies that are phase-modulated by the disturbance on return.

35. (Currently Amended) An apparatus for evaluating the position of a time-varying disturbance on a transmission link, the apparatus including:

an optical pulse source;

a first differential power splitter for copying, at least in part, an output signal from said optical pulse source, such that there is a pair of signal copies by channeling light from the optical source onto first and second paths such that the power of said optical source traveling along each path is shared in a predetermined manner between said signal copies and one signal copy travels along said first path in an outbound direction with the other signal copy traveling along the second path in said outbound direction;

a delay stage for delaying one of the pulse copies relative to the other pulse copy in said outbound direction;

a coupler for combining light traveling in the outbound direction;

a transmitter for transmitting the combined light of the differentially delayed pair of signal copies onto the transmission link in an outbound direction;

wherein the coupler is arranged to act as a second power splitter for light received in a return direction from the transmission link, wherein the light received in the return direction comprises backscattered components of said combined signal copies of a transmitted pair which has traveled along the transmission link to beyond the location of the time-varying disturbance originally transmitted in said outbound direction, wherein at least one of said backscattered components has suffered a phase change caused by said time-varying disturbance, such that the intensity of the return signals is split with one portion being channeled along the first path, and the other portion being channeled along the second path;

wherein said first differential power splitter functions to combine the received returned signal copies of a transmitted pair so as to produce a combination signal;

a signal processing system for evaluating using a temporal characteristic in the combination signal the position of the time-varying disturbance on the transmission link, wherein the position of the disturbance is determined from the time of return of said phase-modulated backscattered components of said returned signal copies, the phase-modulated backscattered components including backscattered components of a given pair of pulse copies that are phase-modulated by the disturbance on return.